Research Article

Changes of blood shock volume among the children with hypokinesia

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ABSTRACT

Objectives: Peculiarities of the changes in the indexes of the pumping function of the children's hearts, with different levels of preliminary physical readiness, were studied with a subsequent sharp restriction of motor activity. **Materials and Method:** The studies were conducted at the Traumatology Center of the Republican Clinical Hospital of RT Ministry of Health for 2 years. They examined indicators of pumping function of child heart among the hospital children with the fractures of the lower extremities, as well as with injuries of the spine. **Results:** It was found that in children who systematically engaged in sports before admission to the hospital, with subsequent severe restriction of motor activity, the shock volume of blood does not undergo significant changes during the 4 weeks of hypokinesia. **Conclusion:** In children who are not engaged in physical culture and sports before entering the hospital, the magnitude of the shock volume of blood during the first 3 weeks of the restriction of motor activity does not change, and in the subsequent, i.e., in the 4th week of strict bed rest (hypokinesia) is reliably reduced.

KEY WORDS: Hypokinesia, Muscle training, Pumping function of the heart, Stroke volume of blood, Trauma, Children of school age

INTRODUCTION

In most diseases, associated with the musculoskeletal system, doctors recommend to rest, i.e., the restriction of motor activity. However, many researchers note that the limitation of muscle activity leads to significant changes in a human body.[1-3,9,10] In the book "Hypokinesia," Kovalenko and Gurovsky[3] noted that a prolonged restriction of motor activity is one of the factors contributing to the development of cardiovascular diseases among people. The changes in the heart rate are described even at 4 h stay of the subjects in a special chair and during 10-day hypokinesia.

At the same time, quite often, there are the works in literature showing that the cardiac rhythm is not changed when the motor activity is limited or some increase of the heart rate occurs only at the end of hypokinesia period. At that, it should be noted that most of the studies were carried out on an adult body. Moreover, the changes, taking place in the parameters of the pump function of the children heart, remain completely unclear due to the transition from one motor regimen to the diametrically opposite one.[4]

They showed in a number of studies that under the conditions of limited muscle activity, the volume of circulating blood decreases due to plasma volume and shaped element decrease.[6,7] At that, other researchers failed to find a correlation between the decrease of water volume in a body and the volume of circulating plasma during hypokinesia.[9] A number of authors indicate the changes in the shock volume of blood during the transition from the usual motor regimen to conditions of limited mobility.[3,5]

Thus, even a poor analysis of literary sources indicates that researchers have no common opinion on this issue. Moreover, basically, all these studies were conducted on adults. Whereas, the changes occurring in the indicators of the shock volume of children blood at a sharp restriction of motor activity remain almost unexplored.

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Study Objective

The objective of this study was to study the reaction of the shock volume of blood of a developing organism with a sharp restriction of motor activity.

STUDY METHODS

To determine the shock volume of blood, they used tetrapolar thoracic rheography.[8] The principle of impedance electroplethysmography method is to record the oscillations of the complex electrical resistance (impedance) of a bioobject to a high-frequency current; the resistance fluctuations are proportional to blood supply changes. Enhanced by electronic devices and recorded graphically, these resistance changes form a curve called rheogram (rheo - flow). The method has a number of undeniable advantages: Non-invasiveness and promptness, continuity and any duration of observation, technical simplicity and absolute atraumaticity, and the possibility of measurements during free breathing.

RESEARCH METHODS AND ORGANIZATION

The studies were conducted at the Traumatology Center of the Republican Clinical Hospital of RT Ministry of Health for 2 years. They examined indicators of pumping function of child heart among the hospital children with the fractures of the lower extremities, as well as with injuries of the spine.

Children were conditionally divided into two groups. The first group included the children at the age of 9–14 years who were systematically engaged in physical training and sports before entering the hospital. The total number of these children was 18 people.

The second group included the children of the same age who were not systematically engaged in physical culture and sports, i.e., were classified to a special medical group for health reasons, also injured in the lower extremities or the spine and admitted to the hospital for treatment. The number of such children was 19 people.

RESULTS OF OWN STUDIES AND THEIR DISCUSSION

The shock volume of blood was 44.7 ± 0.9 ml among the children, who were engaged in physical training and sports (the main medical group) systematically, during the hospital entrance. During the 1st week of motor activity restriction, the systolic ejection increased to 53.6 ± 0.7 ml. This value was greater by 0.9 ml, as compared with the initial values of the shock volume of the blood ($P < 0.05$).

At the end of the 2nd week of hypokinesia, the shock volume of blood was reduced to 45.4 ± 0.8 ml, that is, approximately to the initial value. During the next 3 weeks, the limitation of motor activity among the children classified to the main medical group by health status, the shock volume of blood did not undergo significant changes, remaining approximately at the level of 45–44 ml.

Consequently, the children systematically engaged in physical culture and sports experience the increase of systolic ejection during the 1st week of hypokinesia. However, by the end of the 2nd week of motor activity restriction, the stroke volume of blood (SVB) decreases to about the initial values and subsequently does not undergo significant changes during the next 3 weeks of hypokinesia.

The children who are not engaged in physical culture and sports, i.e., attributed to the special medical group for health reasons, had the shock volume of blood equal to 35.8 ± 1.1 ml when they entered the hospital, which was 0. 9 ml < the amount of SVB among the children of the same age, referred to the main medical group by health status ($P < 0.05$). The restriction of the motor activity among the children of the special medical group during the 1st week resulted in SVB gain up to 49.4 ± 1.2 ml, which is 13.6 ml more, as compared with the initial values of systolic ejection ($P < 0.05$). During the 2nd week of hypokinesia, the shock volume of blood among these children remained at a high level (49.7 ± 0.9 ml). By the end of the 3rd week, the limitation of motor activity among the children assigned to a special medical group resulted in SVB decreases down to 37.3 ± 0.7 ml, that is, approximately to the initial value of systolic ejection. In the course of the 4th week of hypokinesia, the decrease of SVB was observed down to 31.7 ± 0.7 ml. This decreases of systolic ejection, although it does not reach a reliable value in comparison with SVB values of the 3rd week; however, the tendency for SVB decrease persists among these children. By the 5th week of hypokinesia, the SVB values did not undergo significant changes and remained at the level of 31–32 ml [Table 1].

Consequently, a significant increase in systolic ejection is observed among the children who did not engage in physical training and sports during the 1st week of motor activity limitation, as compared with the initial values of the shock volume of the blood. High values of SVB persist also during the 2nd week of hypokinesia. The reduction of SVB to a similar level among the children of this group is observed at the end of the 3rd week of motor activity restriction. The tendency to SVB decrease persists during the 4th week of hypokinesia. During the 5th week of motor activity restriction, there were no significant changes in SVB.

Table 1: Changes in the shock volume of blood among the children engaged and not engaged in muscle training

Groups	Hypokinesia stages					
	Initial data	1st week	2nd week	3rd week	4th week	5th week
Special g.	35.8±1.1	49.4±1.3*	49.7±1.2	37.3±0.7*	31.7±0.4	32.4±0.7
Main g.	44.7±0.9	53.6±0.7*	45.4±0.8	44.4±0.7	45.1±0.9	44.6±0.9

*Significant changes in comparison with baseline values (P<0.05)

SUMMARY

According to our studies, the children, who were systematically engaged in physical culture and sports, experienced systolic ejection increase during the 1st week of hypokinesia. However, by the end of the 2nd week of motor activity limitation, the shock volume of blood among these children was reduced to about the initial values and subsequently did not undergo significant changes during the 3 weeks of hypokinesia. Thus, among the children who were systematically engaged in physical culture and sports before entering the hospital for treatment, the values of the shock volume of blood are more stable, despite a sharp decrease of motor activity level.

Analyzing the changes in the shock volume of blood, we found that the children who were not systematically engaged in physical training and sports had a significant increase in systolic ejection before entering the hospital for treatment during the 1st week of severe limitation of motor activity, as compared with the initial values of the shock volume of blood. High values of the shock volume of blood persist during the 2nd week of hypokinesia. The reduction of the shock volume of blood to a similar level is observed among the children of this group only at the end of the 3rd week of motor activity restriction. The tendency to decrease the shock volume of blood is maintained even during the 4th week of hypokinesia.

The following can be noted during the comparison of reactions of the shock volume of blood on a sharp restriction of motor activity among the children systematically engaged and not engaged in physical culture and sports. Both groups of children demonstrate systolic ejection increase during the 1st week of hypokinesia. However, the increase of the shock volume of blood is more pronounced among the children not engaged in physical culture and sports. Moreover, high rates of stroke blood volume persist among these children during the 2nd week of motor activity limitation. Whereas, among the children who systematically engaged in muscle training before admission to the hospital, the shock volume of blood decreased to about the initial level by the end of the 2nd week and subsequently did not undergo significant changes during the next 3 weeks of hypokinesia. The reduction of the shock volume of blood to the baseline values among the children not engaged in physical culture and sports occurs only by the end of the 3rd week of hypokinesia. The tendency to systolic ejection decrease among these children is also observed during the 4th week of hypokinesia.

CONCLUSIONS

1. The shock volume of blood does not undergo significant changes among young athletes during all 4 weeks of hypokinesia.
2. Among the children who do not engage in physical culture and sports, the magnitude of the shock volume of blood does not undergo significant changes during the first 3 weeks of hypokinesia, and it decreases subsequently.

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REFERENCES

1. Vakhitov IK. Pumping Function of Heart, Depending on the Age of Initiation to Muscle Training. Author's Abstract from the Diss. Kazan: Document of Biology; 2005. p. 18.
2. Dembo AG, Zemtsovsky EV. Sports Cardiology: The Guide for Doctors. Moscow: Medicine; 1989. p. 464.
3. Kovalenko EA, Gurovsky NN. Hypokinesia. Moscow: Medicine; 1980.
4. Sitdikov FG, Rusinova SI. The changes in cardiovascular and sympathoadrenal system among the children of primary school age during the school year. Hum Physiol 1992;3:88-95.
5. Khrushchev SV. Problems of Hypokinesia and Hyperkinesia among Children. Sov Pediatrics. Moscow: Medicine; 1983. p. 244-52.
6. Aubert AE, Beckers F, Ramaekers D. Short-term heart rate variability in young athletes. J Cardiol 2001;37 Suppl 1:85-8.
7. Allen JD, Geaghan JP, Greenway F, Welsch MA. Time course of improved flow-mediated dilation after short-term exercise training. Med Sci Sports Exerc 2003;35:847-53.
8. Kubicek WG, Kamegis JW, Patterson RP, Witsoe DA, Mattson RH. Development and evaluation of an impedance cardiac output system. Aerospace Med 1966;37:1208-12.
9. Bouchard C, Rankinen T. Individual differences in response to regular physical activity. Med Sci Sports Exerc 2001;33:S446-51.
10. Boutcher SH, McLaren PF, Cotton Y, Boutcher Y. Stroke volume response to incremental submaximal exercise in aerobically trained, active, and sedentary men. Can J Appl Physiol 2003;28:12-26.

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